CURRENT SCIENCE

Vol. XIV] JULY 1945 [No. 7

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A DECIMAL COINAGE SYSTEM FOR INDIA

THE Government of India have recently circularised, for the purpose of eliciting public opinion, the outlines of a plan to decimalise the coinage of the country. The plan, in brief, is to divide the existing rupee into 100 cents. The present one-rupee, half-rupee and quarter-rupee coins would continue to be minted in their existing size, shape, weight and metal content; only the half-rupee would be designated 50 cents and the quarter rupee as 25 cents. Coins of lower denominations are proposed to be replaced, under the new system, by 10, 5, 2, 1 and perhaps also ½ cent coins. The two sets of coins would naturally have to circulate and will be freely interchangeable during a transition period in the course of which there will be no fresh minting of the annas and pies and their gradual withdrawal leading to the eventual and complete elimination of these coins.

Any change in the coinage system of a country is a serious matter affecting as it does the daily life of the individual and of the community at almost innumerable points. Government would, as is easily understandable, be reluctant to sponsor any reform with such profound and far-flung consequences unless they be assured of at least a certain modicum of public support. Government are now engaged in ascertaining the extent of such support. We are not, however, aware of any special measures adopted by Government to consult men of science and organised scientific opinion. But, these latter are as much interested, to put it no higher, in such a proposal as other sections of the community. For, decimalisation of coinage—quite apart from its being desirable in itself—is an important precedent to and in some ways a powerful lever for similar transformation in the weights and measures employed by the community and these in their turn, pave the way to a completely rationalised system of the expression of all quantitative values in decimalised units. A decimalised system is a *scientific* system.

The case against the proposed change may first be summarised. It will involve the adaptation of the entire price, wage and rate structure of the community—changes which necessitate a colossal amount of extra work and will also, let it be admitted and faced, lead to inevitable friction, misunderstanding and even fraud in the earlier stages. Certain subsidiary changes will also be forced on the community which, again, will have to pay for it in the long run—such, for example, as the adaptation of rail-tickets, postage stamps, automats, actuated by coins, to name a few. The change will provide a wide and fertile field for the unsocial elements of the community to exploit large masses of the uninformed, the illiterate and the gullible. This can never be prevented although much could be done (and the Government propose to take special measures on this behalf should the new coinage be decided upon) to minimise the evil. There is also the element of sentiment and tradition—imponderable but nonetheless very real factors to contend with—which in this country are exceptionally strong. This conservatism would of course not take kindly to any innovation in coinage and might put in obstacles in many unexpected ways whose net effect would be to slightly depreciate the new coins against those which are to be replaced.

On the other hand, the case for the change is necessarily based on a long-term assessment of the accruing advantages. The first and foremost of these is the enormous simplification and saving in time which the new system would ensure in calculations and accounting. The money value of this saving in time and effort would be the equivalent of lakhs of rupees annually to industry and commerce alone. As for the educational value of the proposed change, it would be a veritable boon to children of the school-going ages,

It may at once be said that the lessening of the strain involved in memorising and interrelating to the rupee-annas-pies trinity by the elementary school-going children alone would be worth and more than worth all the expense and trouble involved in the change-over. Next to the burden of learning his lessons through a medium other than his mother-tongue, one of the most serious handicaps to the unfortunate Indian student of tender years is the bugbear of manipulating "Tables"—arbitrary units of money, weights and measures. It is a tragic waste of effort. And viewed from this angle, a decimal coinage system would constitute a great gift of the present generation to posterity—especially to the generations of students yet to come. Amongst much less important advantages, mention may be made of the fact that the most modern accounting and computing machines are designed to be adaptable to the decimal system and a country which clings to outworn arbitrary systems perforce will deny itself these aids of the modern business world. All things considered, the advantages of decimalised coinage are so overwhelming that many of the countries even in the slow-to-change Orient have switched over to decimal coinage. Malaya, Netherlands, Iraq, Palestine and Thailand all have decimal coinage. India's close neighbour, Ceylon, has her rupee divided into 100 cents. In Europe, Great Britain is the only important country not to have decimal coinage. Indeed, in the whole world, it is only parts of the British Empire that form the most notable exceptions to the tendency of all progressive nations adopting the decimal system of coinage.

Now, the point to remember is that these countries in changing over from their outmoded systems to the decimal system knew and did pay the cost involved and inseparable from such a change. Some of these countries had to contend with obstacles similar to Indian conditions. Thus Russia who completed her decimal coinage transformation in 1897 had to reckon with masses of a predominantly agricultural population—mostly illiterate—spread over vast areas not well-served with transport. But, the new system was introduced. To repeat, the price of the change is high but the charge is worth the price. In this connection, it is interesting to recall that a proposal was afoot just before the present war that the right angle be divided into 100 degrees. It was conceded by the sponsors that the task of recomputing mariners' charts and tables alone on the new division would be a stupendous task but the advocates of the proposal were definitely of the opinion that this difficulty was not insuperable and must be squarely faced. The question could not, however, be considered fully on its merits owing to the war intervening. It is mentioned here just to indicate the trend of progressive world opinion in such matters.

While the difficulties are there, India at present will enjoy certain advantages which makes the change-over—should it be decided upon—about the least painful. The chief of these is the fact that quite apart from any change in the coinage system, the Government have a programme, in the post-war period, of large re-coinage operations. Owing, partly to the increase in currency circulation and partly due to the necessity of conserving critical metal supplies, the Indian mints put in circulation during the war large numbers of coins of altered format and alloy-content which are not exactly popular. Also, the circulation of nickel alloys had been strictly regulated. It is, however, the view of coinage experts that cupro-nickel alloys are preferable for coinage to the bronze alloys in India where the common use of brass for domestic utensils lends bronze coins to easier counterfeiting. For these and other reasons, there will be a large re-coinage programme in Indian mints immediately after the war when nickel is not subject to wartime rationing. An excellent opportunity will thus be presented to issue decimal coinage without undue expense being incurred solely for this purpose. Other favourable factors in India in the immediate future are, that a period of contracting currency is better for an innovation of this kind than an inflationary period. Also, an increase in the standard of living which all post-war planning is dedicated will render smoother the acceptance of the proposed one cent (1/100 of the rupee) as the smallest coin (should the ½ cent coin be not issued in the new scheme) in the land in place of the existing one pie ($^1/_{192}$ of the rupee) which at the present level of prices has already very largely ceased to play a role in the daily transactions of the community. Still another helpful factor would be that the National War Front and allied quasi-official organisations which have been built up for war purposes could well be utilised in explaining, again without extra expense on this account, and familiarising the new coinage to the people in every nook and corner of the country thus neutralising to some extent at least the victimisation of the ignorant.

Finally, it has to be remembered that for sweeping changes of this kind, in a country like India (for that matter, only perhaps not to the same extent, in *any* country), a slight element of compulsion—a gentle "leading in by the nose"—would seem to be nearly indispensable. The change-over to "Summer Time" in European countries is a case in point. All kinds of dire calamities were freely prophesied in the early stages when the innovation was first made but people gradually reconciled themselves and then began to appreciate the rationale and convenience of adjusting their clocks to practical needs every winter and summer. In our own country, the furore which the advancing of the Indian clock, in 1942 raised is nearly forgotten now. It is safe to presume a similar adjustment of the community to a change in its coinage. Only, the period of readjustment may take longer. One should prepare for its being so in a predominantly agricultural country like India where exotic practices are sanctified to a stage when their essential irrationale is masked by the veneer of usage and convention. (Such for example are the hours during which Indian offices and schools work; why, even the hours of play often!). The present coinage system is one of these anachronisms—only much bigger in magnitude and more ramified in its effects. Its replacement by a rational system of coinage does involve heavy sacrifices on

the present generation. But, the change is well worth the price and the price to be paid will be at about its minimum in the immediate post-war period. Such an opportunity may not recur for a very long time to come. Now, therefore, is the time to introduce a decimal coinage system in India.

INDIAN INDUSTRIALISTS' DELEGATION IN THE UNITED KINGDOM

A DELEGATION of Indian industrialists, led by Mr. G. D. Birla and Mr. J. R. D. Tata, have just completed a tour of the United Kingdom and are at present in the United States. The objects of these visits are broadly stated to be to explore the possibility, extent and terms on which the co-operation and assistance of British and American Industry could be had in the post-war development of Indian industry.

The influential membership of the delegation, the importance to the country of the subjects they were handling and the elaborate preparatory work for their reception and programme abroad all served to focus public attention in this mission which, however, had had even more than its normal share of spotlight thrown on it due to some critical comments from Mahatma Gandhi. This opportunity was availed of by the members of the delegation in reiterating what they had already stated publicly and unambiguously on the status and scope of the mission. The industrialists were going abroad as private individuals at their own expense and on their own responsibility with no commission or intention of committing any one excepting themselves in their negotiations abroad.

Messages in the daily press have given accounts of the cordiality with which the members have been received and the numerous industrial and technical establishments through which they have been conducted. The press has also recorded the conclusion of some definite agreements as for example, a co-operative enterprise between the Birla and Nuffield interests to start a factory in India, to begin assemblage and ultimately manufacture Morris Cars in India. The following message from the London correspondent of the *Capital* to his paper on the eve of the delegation's departure to the United States well summarises the work of the delegation; says the correspondent, "The Indian industrialists who have been visiting us, are on the verge of departure for the United States. They beam with happiness. They have seen as many of our great industrial works, and as much of them, as they desired ..... All this is not saying that no questions of importance, or anxiety, remain unsolved or are still rather perplexing ..... The mutual changes of outlook are expressed in some pretty important, newly negotiated, contracts. How many is not to be said here. One seems always hearing something fresh in that line ....."

Apart from these and similar agreements which individual members might have concluded on behalf of the interests they represent, the visit of the delegation seems to have been productive of results of a larger order benefiting the country as a whole. There was an impression abroad, by no means uncommon, that the Indian businessman was usually a "merchant"—a sort of glorifical agent who "represented", for a commission, the foreign manufacturer. While the merchant does continue to play his useful and honourable role in the country even now, it is not appreciated adequately abroad that the Indian businessman to-day is also a progressive and enlightened *manufacturer*—investing capital with its attendant risks, producing goods with the requisite competitive skill, handling labour with its attendant problems and selling them in the open market on his own account *and* making a profit. Thus, for example, the outstanding fact that one of the largest Iron and Steel plants in the British Empire, is owned and operated by Indians at Jamshedpur is often missed, at least by implication, by many. And quite a few industrialists should have been surprised that the Indian visitors could hold their own in any parleys regarding their particular industry, both in the technical and organisational aspects. And it is on such mutual knowledge that respect and appreciation of the various interests involved are born, and it is on these, in turn, that any stable business relationship can be built. There could be no doubt that the visit of the Indian Industrial Delegation has helped to foster such relationship.

Secondly, the activities of the delegation have made a definite contribution to the more widespread realisation in Britain that the industrial prosperity in India need not be at the expense of any other country. Lord Nuffield has recently given eloquent expression to such sentiment, as follows: "There are people who would lament that this progressive industrialisation of the Empire means a concomitant decline in British Exports. I absolutely disagree. Indeed, I contend that the contrary will be the case. The more Indians who exchange the pittance from the paddy fields for the higher wages of the Motor Car assembly factory and the more Indians who ride in motor cars, bringing the inevitable opening up of new roads and trades in the backward villages, the more tremendous will be India's demands for all manner of British exports goods that in the bad old days of muddy lanes and bullock carts, the bulk of her people could never afford."

In wishing the delegation a pleasant and useful sojourn in the United States also, *Current Science* hopes that these unofficial ambassadors of Indian Industry will not have failed to notice the generous and extensive manner in which industry in these foreign countries have nourished and sustained scientific research from which in turn, industry derives its strength and competitive position. Such appreciation and its translation to action in India might well prove to be the most fruitful by-product of these tours of the delegation abroad.

A LINEAR TIME INTERVAL METER

By N. B. BHATT, Sc.D.

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THE change of voltage developed across the plates of a condenser which is either being charged by a steady source of potential E_0 in series with a resistance or discharged through a resistance, is extensively used as a measure of the time interval during which either process has taken place. The basis of this is the well-known relationship which, however, gives the voltage across the condenser as an exponential function of time. Various devices have, therefore, been employed to obtain linearisation of the voltage-time relationship since the R C circuit forms a very convenient time base in Cathode-Ray Oscillographs. In a recent publication Puckle[1] has given a detailed account of several such circuit arrangements.

Walker[2] has described an instrument for measuring short intervals of time wherein he has assumed the essential linearity of the voltage-time characteristics during the first 5 per cent. rise of the total voltage E_0 aeross the plates. The voltage-efficiency of such a charging circuit is quite poor inasmuch as 95 per cent. of the supply voltage stands idle except for its contribution towards the initial linearity. The so-called "Constant Current" charging circuit employs a pentode tube operated above the "knee" of its plate current-plate voltage characteristics, in place of the constant resistance element. Such an arrangement approximates fairly to a constant rate of charge and the voltage efficiency of the circuit depends on how high the supply voltage is kept above the "knee" in the pentode characteristics. This device, therefore, necessitates the use of a steady source of the order of a few hundred volts.

The present communication describes a time interval meter employing the ordinary R C circuit the exponential voltage rise across the condenser of which is compensated in the indicating device which is a vacuum tube voltmeter working on the curved portion of its dynamic characteristics. Within the degree of compensation achieved, therefore, the indications of the meter are directly proportional to time. The obvious advantage of this method is that a charging voltage of much smaller magnitude is used and it is found, as will be seen later, that the voltage efficiency is over 55 per cent. with a good degree of linearity provided the value of the charging voltage, the vacuum tube and its asociated circuit are properly chosen. Mention has been made in literature of this "linearisation by the inverse curavture of vacuum tube characteristics;"[3] but so far as the author is aware no detailed investigation has been reported regarding particularly the degree of linearity and the voltage efficiency obtainable in this manner when small charging voltages are used.

Fig. 1 shows the circuit assembly, the timing part of which forms the grid circuit of RCA-1D5GP type tube having remote cut-off characteristics. The two relays S_1 and S_2 mark the beginning and the end respectively of the time interval to be measured. Initially both S_1 and S_2 are closed and the grid of the tube has a large negative bias to give no indication in the plate meter M. At the commencement of the interval S_1 opens up and removes the short circuit of the condenser C which starts to charge up, thus lowering the value of the negative bias on the grid in the process which results in a deflection of M. S_2 opens at the close of the interval and stops

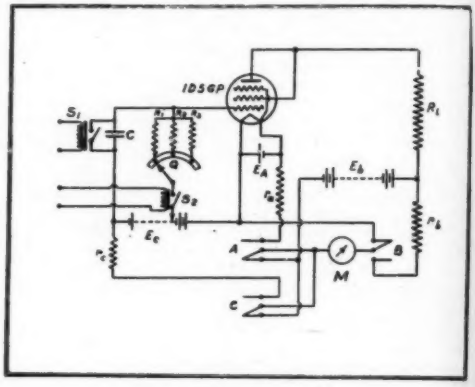

FIG. 1

the charging of C. The indications of M thus obtained are made proportional to time by previously adjusting the charging voltage E_0 in the timing circuit and the initial grid bias, plate voltage E_b and the load resistance R in the vacuum tube circuit. Fig. 2 shows a few of these two sets of characteristics; the dotted curves give the voltage time characteristics for three different values of E_0 and represent solution of the equation

$$E = E_0\left(1 - e^{-\frac{t}{CR}}\right) \qquad (1)$$

for $E_0 = 14^v, 16^v, 18^v$; $C = 0{\cdot}875$ mF; $R = 1{\cdot}57$ meg.

The solid curves in Fig. 2 represent the dynamic characteristics of the vacuum tube 1D5GP for two different values of the load resistance with 80 volts on the plate; these values have been so manipulated that the $i_p - e_g$ curve in the region of interest obeys the following relationship :

$$i_p = Ae^{be_g} \qquad (2)$$

where i_p *is the plate current* in milliamperes, e_g is the grid voltage and the constants A and b are positive numbers. A plot of $ln\ i_p - e_g$ results in a straight line whose slope directly gives b, A being calculated therefrom. It would be true to say that i_p equals A at zero

grid bias voltlage, provided only that the region of the zero grid voltage is included in

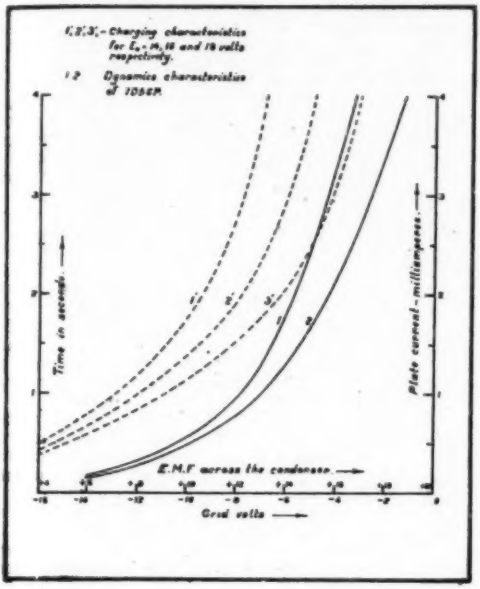
1, 2, 3, - Charging characteristics for E_0 = 16, 12 and 10 volts respectively.
1' 2' Dynamic characteristics of 1054P.
Time in seconds.
Plate current - milliamperes.
E.M.F. across the condenser
Grid volts

FIG. 2

the validity of equation (2). If not, the experimental value of i_p at $e_g = 0$ will normally not be equal to A.

Both the characteristics are plotted on the same abscissa since by applying Kirchoff's Law to the circuit we get the following equation

$$E_c + e_g - E = 0 \qquad (3)$$

where e_g is the net voltage on the grid E that across the condenser C at any time and E_c is the value of the total voltage of the source (this is different from the charging voltage E_0). Therefore, indications given by the meter M in Fig. 1 represent those values of time which intersect the same vertical line corresponding to a definite value of the voltage in Fig. 2. In this manner a plot of $i_p - t$ for a given pair of charging characteristics and $i_p - e_g$ characteristics is obtained and is shown in Fig. 3. It will be seen that this curve is fairly linear over its major portion with sharp curvatures at either ends. The extent of linearity and the slope of the plot thus obtained depend on E_0 on one hand and A and b of the dynamic characteristics on the other. Out of a number of possible combinations it is possible to select one which will give the best compromise between linearity, voltage efficiency and sensitivity. In the present case the charging voltage E is kept at 16 volts and the dynamic characteristic chosen has $A = 11{\cdot}0$ and $b = 0{\cdot}303$. The plate meter has a range of 0-3 ma. and will give a full-scale deflection when t goes to infinity. Under these conditions for a 3 per cent. change

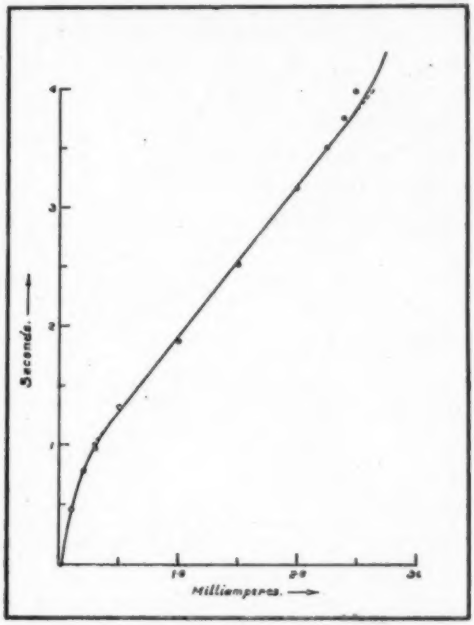

FIG. 3

of linearity the voltage efficiency is over 55 per cent.; and within this degree of linearity the deflections of the meter are non-linear over a total of only 10 per cent. of the scale divisions at both ends as shown in Fig. 4.

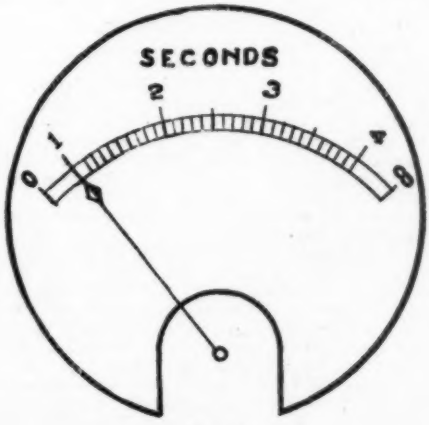

FIG. 4

The selection of a suitable pair of characteristics is much facilitated by an analytical

relationship between i_p and t. Rewriting equations (1) and (2) we get

$$E = E_0\left(1 - e^{-\frac{t}{CR}}\right) \quad (1)$$

$$e_g = \frac{1}{b} ln \frac{i_p}{A} \quad (4)$$

substitution of (1) in (3) gives

$$e_g + E_c = E_0\left(1 - e^{-\frac{t}{CR}}\right) \quad (5)$$

substituting for e_g in (5) from (4) and solving for t we get

$$t = -RC\, ln\left[K - \frac{1}{bE_0} ln\, i_p\right] \quad (6)$$

where $K \equiv 1 + \frac{1}{E_0}\left[\frac{1}{b} ln\, A - E_c\right]$

Inserting the values for E_c, E_0, A and b for the specific case given in Fig. 3, equation (6) reduces to the following form:

$$t = -RC\, ln\,(0{\cdot}244 - 0{\cdot}206\, ln\, i_p) \quad (7)$$

Points computed from the above relationship have been marked as circles along with the experimental plot in Fig. 3. The divergence of the computed points from the experimental curve for values of i_p above 2·5 ma. is due to its departure from the relationship given by equation (2) in that region; however, this has been advantageous here for extending the region of linearity.

In actual rig-up the instrument employs two identical Western Electric Telephone Relays operating on a current of about 1·0 ma. through the coils energised by external agencies *via* the two pairs of terminals provided. The timing circuit utilises a Western Electric mica condenser and wire-wound resistances whose values are accurately determined. Three such resistances are selected by switch Q for three ranges covering 0·1-4·0 seconds. Inclusion of a further lower range may not be possible due to the finite time lag in the electromagnetic relays used. Great care has to be taken to prevent electrical leakage by mounting all the components of the timing circuits on high insulators; relay contacts should be kept clean and should have a high leakage resistance, an indication of which is the constancy of a reading over comparatively much longer duration. The low filament current (60 ma.) of the tube 1D5GP permits a complete dry battery operation, which, besides making the instrument self-contained, offers steady potentials essential for preserving the calibration. Provision is made to check all the voltage on the meter by pressing the appropriate pushbutton switches A, B and C as shown in Fig. 1.

The instrument has been developed in the laboratory in connection with measurements of sound intensities at various levels during its grow and decay in a reverberation chamber. It will also be found useful in a variety of fields where intervals of time are to be determined with a fair degree of accuracy.

The author is indebted to Mr. B. Subramaniam, B.Sc. (Hons.), for the necessary data embodying Fig. 2.

1. Puckle, O. S., *J.I.E.E.*, 1942, **89**, Part III, 100. (See also *Time Bases*, 1943, Chapman & Hall Ltd.)
2. Walker, E., *Jour. Frank. Inst.*, 1941, **231**, 373. 3 Puckle, O. S., *Loc. cit.*

INFLUENCE OF MERCURY ON INSECT EGGS—PART II

By

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I. Internal changes caused by the penetration of mercury vapour into the eggs

EGGS of *Corcyra cephalonica*, 16-hours old, were exposed, for 48 hours, to the lethal dose of mercury previously determined, in a closed cylindrical jar of known volume. Necessary controls were maintained.

Microtome sections of exposed and sound eggs were examined.

The sections of the sound eggs revealed a normal proliferation of the cells and the formation of the embryo; the differentiation of the midgut and the floating cells within the lumen and the epithelial cells lining the midgut could all be clearly observed (see Fig. 1).

Sections of the exposed eggs showed little definition of the cells; the cytoplasm and nuclei were found in different stages of disintegration. The midgut could not be distinguished nor the epithelial cells. A heavily stained mass of fat, albuminoid and disorganised yolk was seen to fill the entire space (Fig. 2).

A 48-hour period of exposure was adopted since it represents the minimum period of mercury to penetrate and kill the eggs. Ninety-six hours' exposure showed complete destruction of the cellular and nuclear structures. The shrinkage of the disintegrated matter resulted in the formation of a blank cavity. Heavy precipitation was also quite evident.

These observations show that mercury vapour disintegrates the cellular contents and structures either partially or completely depending on the length of exposure.

II. Effect of mercury in grainfilled space

The dosage of 0·03 gm. of mercury effective in 3,300 c.c volume of empty space, did not prove uniformly effective against eggs placed at different points in a similar volume of grainfilled container. Only eggs, kept at a depth of 2·5 cms. below the level of mercury, were killed. Tests were, therefore, conducted with higher weights of mercury to find out the minimum lethal dose for 3,300 c.c. of

grainfilled space. The eggs were placed at the middle and also at the bottom of the grainfilled receptacle; the mercury was placed at the top. The results are given in Table A.

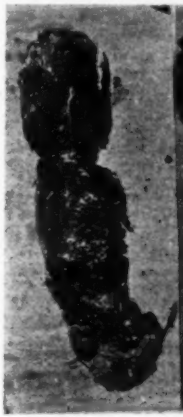

FIG. 1

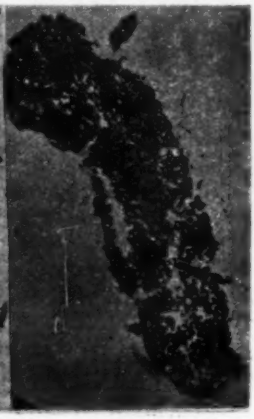

FIG. 2

1. Longitudinal section of sound egg (nearly 64 hours old showing the normal formation and development of larval embryo.

2. Longitudinal section of affected egg (nearly 64 hours old) showing mostly heavily stained fat and other disorganised materials.

TABLE A

Weight of Mercury	Percentage of Kill
0·03 gm.	Nil.
0·04 ,,	Nil.
0·05 ,,	82
0·06 ,,	100
0·10 ,,	100
0·40 ,,	100

III. Correlation between volumes of empty and grainfilled spaces and the effective lethal doses of mercury

A series of tests were made to determine the lethal doses of mercury for increased volumes of empty and grainfilled spaces. In all the tests, mercury was placed at the top and the eggs at the bottom of the receptacles. Volumes (of empty space) such as 4,000, 6,600, 8,000 and 10,800 c.c., were used (Table B).

TABLE B

Volume	Empty Space		Grainfilled Space	
	Weight of Mercury	Percentage of Kill	Weight of Mercury	Percentage of Kill
4000 c.c	0·05 gm.	100	0·10 gm.	100
6600 ,,	0·06 ,,	100	0·12 ,,	100
8000 ,,	0·10 ,,	100	0·20 ,,	100
10800 ,,	0·18 ,,	100	0·36 ,,	100

Similar volumes of grainfilled space were also taken and different weights of mercury used in each case, in order to fix the effective doses for those volumes. In all these cases, the mercury was placed on the top surface of the grain and the eggs exposed, one lot at the middle and the other at the bottom. It was considered necessary to have this arrangement in these tests, since, in natural storage of grains either in bins or bags, the insect infestation (egg stage especially) is mostly always confined to the surface layers and very rarely extends to the deeper ones; the mercury vapour traversing downwards, would affect the eggs not only in the layers of the grain immediately below the surface but also those in the central and deeper layers, if for some reason (in the case of loosely packed grain for example) eggs get laid even there.

In all these volumes there is seen a gradual increase in the weight of mercury corresponding with the increase in the volumes of both empty and grainfilled spaces.

IV. Correlation between the effective doses of mercury for similar volumes of empty and grainfilled spaces

From Table B it can be seen that the effective dose for any one volume of empty space is about half that for the same volume of grainfilled space. This simple ratio of 1 : 2 in the case of these particular volumes tested may possibly hold true for still higher volumes of space under similar air-tight conditions.

V. The actual minimum effective (lethal) doses of mercury

It was observed in all the experiments made with the minimum effective doses of mercury for the several volumes of empty and grainfilled spaces, that the mercury did not vapourise completely during the period (the normal period required for unexposed eggs to hatch) it was allowed to act on the eggs, but that a portion of it remained over as solid metal. This residual mercury was weighed in each case and the difference between the weight of the metal originally determined as the minimum effective dose and the residual mercury was noted. The difference proved to be that actual weight of mercury which was definitely used up in the form of vapour during the period of each experiment. This weight of mercury is, therefore, to be considered as the ultimate and actual minimum effective dose as against the original weight which can only be the apparent minimum dose.

It might be mentioned here that though the apparent effective weight of mercury is many times more than the actual effective weight, quantities of mercury less than the minimum apparent effective weight (for a given volume) of mercury were not found to be effective. This may be because of the limiting factor—the normal period of hatching of the eggs (four days)—during which time the vapour pressure inside the container has to attain the optimum to affect the eggs.

One of the aims of these experiments was to see if any definite ratio existed between increasing volumes of empty and grainfilled spaces and respective effective doses of mercury. Referring to the figures in the tables, it is, however, seen that no clear and definite

ratio appears to exist between either the apparent minimum weights of mercuty or the actual minimum weights of mercury with reference to increases in volumes of space. This is probably partly because the increases in volumes of space so far employed in these experiments are so small that the corresponding effective minimum weights differ very little from one another or remain practically the same.

VI. Effect of actual minimum weight of mercury in the form of amalgam on Corcyra cephalonica *eggs in a given volume of grainfilled space*

A series of confirmatory tests were made with the actual minimum weights of mercury (as shown in Table C) for given volumes of grainfilled space. Being very small quantities, mercury was spread on copper foils and were kept at the top surface of the grains, the eggs being placed at the bottom. Table D gives the results.

TABLE C

Volume	Empty space			Grainfilled space		
	Apparent effective weight of mercury	Actual effective weight of mercury	Percentage of kill	Apparent effective weight of mercury	Actual effective weight of mercury	Percentage of kill
3300 c.c.	0·0306 gm.	0·0006 gm.	100	0·0600 gm.	0·0006 gm.	100
4000 „	0·0508 „	0·0007 „	100	0·1012 „	0·0008 „	100
6600 „	0·0600 „	0·0014 „	100	0·1203 „	0·0014 „	100
8000 „	0·1010 „	0·0016 „	100	0·2008 „	0·0016 „	100
10800 „	0·1800 „	0·0024 „	100	0·3650 „	0·0024 „	100

TABLE D

Volume	Actual weight of mercury in amalgam	Percentage of kill
3300 c.c.	0·0006 gms.	100
4000 „	0·0009 gms.	100
6600 „	0·0014 gms.	100
8000 „	0·0016 gms.	100
10800 „	0·0026 gms.	100

It could be seen from Table D that the actual minimum weight of mercury for a given volume of enclosed grainfilled space, when used as an amalgam, proved to be effective against the eggs. In all the trials the mercury volatilised completely with slight traces at the sides of the copper foils where mercury was invariably thicker than in the centre. Such residual deposits in majority of the cases weighed not more than 0·0001 gm. each.

ACKNOWLEDGMENT

We are very thankful to the Agricultural Chemist and his assistants, for active help in weighing minute quantities of mercury in the chemical laboratory.

CONCLUSION

From the foregoing observations it may be concluded that:—

1. Mercury vapour penetrating the egg of *Corcyra cephalonica* prevents normal embryonic development by causing a destructive disorganisation and disintegration of the cytoplasmic and nuclear structures of the cells.

2. A simple ratio of 1:2 is noted to exist between the minimum effective weights of mercury in certain similar volumes of empty and grainfilled spaces used.

3. No definite ratio is evident between increases in the volumes of empty and grainfilled spaces and the corresponding increases in the minimum effective weights of mercury.

4. The actual minimum effective weight of mercury for any volume of empty or grainfilled space, is only a fraction of the apparent minimum effective weight for that volume.

5. The actual minimum effective weight of mercury for any volume of grainfilled space, if used in the form of an amalgam, is also found to be effective against the eggs.

GEOPHYSICAL PROSPECTING

GEOPHYSICAL methods of prospecting mineral ores and oil resources have assumed great practical importance in U.K. and U.S.A., particularly in the latter country, and spectacular results have been obtained through the application of these methods. Instances of large-scale mapping of ore beds in India, by the application of geophysical methods are few, and for this reason, the results obtained by a party of the Survey of India on the manganese beds in Parsoda area (C.P.) by the use of the gradiometer, reported in the latest issue of the *Journal of Scientific and Industrial Research*, are of more than usual interest. In the area surveyed, a manganese reef has been successfully located. The pattern of the profiles, and the magnitude and depth of the subsurface bodies, have been determined. In alluvial areas of the type surveyed, where no outcrops are available to indicate what is below, geophysical methods are of particular value. They provide valuable preliminary indications and save the expense of sinking random pits. Definite information regarding configuration and depth of the sub-surface body can be obtained by one or two borings.

CENTRAL ELECTRICAL RESEARCH BOARD

THE greatest need of the moment in India is the development of industries and power development in the *sine qua non* for industrialisation. Though some strides in this direction have already been made in recent years, very much more remains to be done. Though India is not favourably placed with regard to the natural supplies of coal and oil, the potential water power resources are indeed very great. On the basis of the Meares Triennial Report, our resources even on the most conservative estimates are about 12 million kw. But the developed resources so far constitute only 6 to 7 per cent. of this potential. Thus in the post-war period attention will have to be first concentrated on the production of power.

In India electric power development would mainly be in the hands of the several Provincial Governments and Governments of Indian States. Further for some of the schemes, such as the Tungabhadra project, the Machand project, etc., co-operation of two or three Governments is essential. Thus there is need for a central co-ordinating body for pooling the resources and for their efficient development. The formation of the Central Technical Power Board by the Government of India is, therefore, most welcome in this connection. The work of the Board would no doubt be directed predominantly towards development of the potential power resources, but in addition is bound to be of invaluable assistance to the existing electric supply organizations and in the development of the electrical manufacturing industry.

At present the electric supply organizations, in India, are severely handicapped as regards technical facilities in solving many of their problems. As an example, and perhaps as one of great urgency, could be mentioned the lack of adequate high voltage testing facilities. A high voltage testing laboratory is essential for solving many of the pressing problems of the electric supply industry—especially transmission and insulation problems which are peculiar to Indian conditions. There are many such problems of electric supply requiring close study, the solving of which would ultimately lead to increase in reliability and effect considerable savings in capital cost and maintenance. In fact, increased use of electricity in industry has really only one limitation—cost. As the cost is reduced there is as yet hardly any limit in sight to further expansion of industry. It is, therefore, imperative that there should be some organization on the lines of the British Electrical and Allied Industries Research Association, England (E.R.A.)* which would undertake to solve the problems of the electric supply industry. The E.R.A. which took its birth during the last World War has even during the short period of its existence, been of immense help to the British Electric Supply and Electrical Manufacturing Industries. The scope of its work and the pressure upon its resources are still rapidly expanding.

As striking examples of the results achieved through the co-operation of the E.R.A. and the electric supply industry, a few may be mentioned.

(i) When the E.R.A. was formed, very little definite knowledge existed on the current-carrying capacity of underground cables. It was the general practice to give such cables too low a rating with the result that inefficient use was made of the vast capital expenditure on cable systems. The work of the Association enabled the permissible loading of many networks to be substantially raised and thus lead to millions of pounds being saved in extensions. The economy effected, by the reduction of the cost of supply, materially assisted the growth which followed.

(ii) In the field of rural electrification, designs of cheap overhead construction for rural distribution have been worked out by the E.R.A. and over 300 of these lines have been successfully operated and have resulted in substantial savings in cost.

(iii) Several years ago, it was estimated that breakdown of insulation in electrical plant was costing the supply authorities and consumers at least one million pounds per annum. It is now admitted that the work of the E.R.A. on this count alone has resulted in savings of nearly 50 per cent.

(iv) Apart from effecting reductions in the cost, many of the researches bear directly upon reliability and safety, thus increasing the public confidence and minimizing the consequential damages due to failures in supply.

Many more examples could be cited, but the above are sufficient to show how useful, indeed, indispensable, an organization on the lines on the E.R.A. would be to the Indian Electric Supply Industry.

As regards the electrical manufacturing industry, at present, India is indeed in a pitiable condition. Even with the existing comparatively meagre consumption of electricity, the annual consumption of electric goods is over Rs. 6 crores. Yet there is no well organized large-scale manufacture. The production is more or less limited to a few articles such as cables and wires manufactured by the Indian Cable Co., at Jamshedpur, small transformers and insulators manufactured by the Mysore Government concerns at Bangalore, and lamps manufactured at Calcutta, Bombay, Agra and Bangalore. These meet only to a very small extent the demands of the country. India is depending on foreign import even for the simplest of her requirements in the matter of electrical equipment. With expansion of power the need for electrical machinery would be greatly enhanced and India can ill-afford to continue to import from abroad. The war has, however, already given a stimulus in this field as in many others, and a number of small concerns are springing up in the country for the manufacture of articles such as fans, heaters, radio components, small motors, electric light fittings, etc. In the post-war period the development would, no doubt, be on a much larger scale. But before an industry could be started and

* Details regarding E.R.A. and its activities are found else where in the issue.

established on a sound basis there would be a number of pressing problems peculiar to Indian conditions, such as a thorough investigation of the question of proper utilization of indigenous raw materials, etc., requiring immediate attention; and in this respect also, India badly needs an organization of the type of E.R.A. which will be of the greatest assistance to the Electrical Manufacturing Industry.

The phenomenal expansion of the electrical and allied industries in the past twenty-five years in England is due to a large extent to the work of the E.R.A. Manufacturers have also found the Association indispensable for the preparation of standard specifications. Mention must be made of the exceptionally valuable work done by the E. R. A. in the field of insulation alone. Their investigations cover a very wide field and include materials such as fabrics, tapes, varnished cloths, varnishes, enamels, filling compounds, paper, mica, asbestos press-boards, vulcanized fibre, ebonite and composite insulating materials based on synthetic resin, etc. The results of their investigations have not only effected definite improvements both in the properties of the insulating materials and in the technique of their selection and utilization, but also have led to considerable expansion of the industries themselves.

Towards its establishment and maintenance the E.R.A. receives generous financial support from the Government through the Department of Scientific and Industrial Research (D.S.I.R.), the Central Electricity Board, the B.B.C. and the G.P.O., the British Electrical and Allied Manufacturers' Association (B.E.A.M.A.), the Institution of Electrical Engineers (I.E.E.), the Cable Manufacturers' Association (C.M.A.) and many electric supply undertakings. The expenditure of the Association is now over £100,000 per annum and would have been much higher had it not been for the diversion of energy and personnel caused by the war effort.

Unfortunately in India there are as yet no organizations corresponding to the I.E.E., B.E.A.M.A., C.M.A., etc., which would supplement Government assistance in the setting up of a Research Association on the lines of the E.R.A. Hence the inception and direction of its activities in the early stages at least will have to rest mainly with the Government through the Central Technical Power Board. Research takes time, yet the results must be available in time for their utilization, hence the problem of providing facilities and building up staff to undertake the researches needed for post-war development is most urgent. A moderate beginning could be made by utilizing the existing facilities for experimental investigations in the laboratories of the Indian Institute of Science, Bangalore, and providing the Institute with some additional equipment of which the most important are those connected with High Voltage Testing, comprising:

(1) One million volt power-frequency testing equipment.
(2) Two million volt impulse-testing equipment.
(3) 200-KV high voltage D.C. testing equipment.
(4) A 125-KV H.F. testing equipment.

The approximate cost of the above equipment based on pre-war prices would amount to about Rs. 4 lakhs. A suitable building to house the above would, in addition, cost another lakh of rupees.

In due course the organization could have its own laboratory and staff.

H. N. RAMACHANDRA RAO.

OBITUARY

THE LATE DR. S. L. GHOSE

THE news of the premature death of Dr. S. L. Ghose, Professor of Botany, Government College, Lahore, has been received with profound sorrow by his numerous friends, colleagues and pupils. His departure from this world at an early age of fifty-two has created a gap in the ranks of Indian workers in Botany which is hard to fill.

S. L. Ghose was the youngest son of Mr. N. C. Ghose, who served as headmaster in many high schools in the Punjab and N.W.F.P. Born on 13th December 1893, he received education in many schools and ultimately passed his Matriculation from the Government High School, Ludhiana. He joined the Forman Christian College, Lahore, in 1908, and developed interest in biological sciences in his early years and in 1910 shifted to Government College, Lahore, where he had a brilliant academic career. In 1921 he proceeded to the University of Cambridge and worked under the guidance of Dr. A. C. Seward and Doctor Borraidale. For his researches on Myxophycæ, he was awarded Doctorate in Philosophy in 1923. He joined the University of Rangoon the same year and was responsible for establishing the Biology Department. In 1928, he returned to Government College, Lahore, as Assistant Professor of Botany, and on the death of Dr. S. R. Kashyap, he was appointed Professor of Botany, which post he held with distinction till his death on March 24, 1945.

He was elected Vice-President of the Indian Botanical Society for 1922-23, and was President of the Botany Section of the Patna Session of the All-India Science Congress in 1933.

His contributions to the study of Myxophyceæ of Northern India and Burma are of an outstanding nature and by his pioneer work he showed the way to others into a realm hitherto practically untouched and unexplored. He was the author of twenty original papers of outstanding merit. By his genial temperament and sympathetic approach he had endeared himself to all his pupils. Besides being an inspiring teacher he was a sympathetic guide in the field of research. Indian Algology has suffered an irreparable loss by the demise of this veteran and the Panjab University an inspiring professor of Botany.

M. S. RANDHAWA.

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A NOTE ON HOTELLING'S T^2

IN a previous note[1] on the generalized variance of a multivariate population it has been pointed out that the generalized variance

$$\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{vmatrix}$$

usually represented by $|a_{ij}|$ is equal to

$$S^2_1 \, S^2_{2\cdot 1} \, S^2_{3\cdot 12} \cdots S^2_{n\cdot 12\cdots n-1},$$

where $a_{ij} = \frac{1}{N} \sum_{\alpha=1}^{N} (x_{i\alpha} - \bar{x}_i)(x_{j\alpha} - \bar{x}_j)$, and $S^2_{n\cdot 12\cdots n-1}$ is the residual variance of x_n of the sample expressed as a linear function of $x_1, x_2, x_3, \ldots x_{n-1}$. $x_1, x_2, \ldots x_n$ are the variates of the population whose means are $m_1, m_2 \ldots m_n$ and N is the size of the sample, $\bar{x}_1, \bar{x}_2, \ldots \bar{x}_n$ are the sample means of the n variates.

This result can be proved by using the relation (given by Yule and Kendall).[2]

$$S^2_{n\cdot 12\cdots n-1} = \frac{\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{vmatrix}}{\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n-1} \\ a_{21} & a_{22} & \cdots & a_{2n-1} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{n-1\cdot 1} & a_{n-1\cdot 2} & \cdots & a_{n-1\cdot n-1} \end{vmatrix}}$$

for $n = 1, 2 \ldots\ldots n$, and multiplying them.

Hotelling's[3] T^2 is defined by the relation

$$\frac{T^2}{N-1} = \frac{|e_{ij}|}{|a_{ij}|} - 1,$$

where $e_{ij} = a_{ij} + (\bar{x}_i - m_i)(\bar{x}_j - m_j)$.

Like $|a_{ij}|$, $|e_{ij}|$ also can be shown to be equal to

$$S_1'' \, S''^2_{2\cdot 1} \, S''^2_{3\cdot 21} \cdots S''^2_{n\cdot 12\cdots n-1},$$

where $S''^2_{n\cdot 12\cdots n-1} = S^2_{n\cdot 12\cdots n-1} + \bar{x}^2_{n\cdot 12\cdots n-1}$, $\bar{x}^2_{n\cdot 12\cdots n-1}$ stands for $[(\bar{x}_n - m_n) - b_{1n\cdot 23\cdots n-1}(\bar{x}_1 - m_1) - b_{2n\cdot 13\cdots n-1}(\bar{x}_2 - m_2) \ldots b_{n-1\cdot n\cdot 12\cdots n-2}(\bar{x}_{n-1} - m_{n-1})]^2$. The b's are the partial regression coefficients of x_n on $x_1, x_2 \ldots\ldots x_{n-1}$ of the sample.

industrial and technical establishments trough

Hence
$$\frac{T^2}{N-1} = \frac{|e_{ij}|}{|a_{ij}|} - 1 = \frac{S''^2_1 \, S''^2_{2\cdot 1} \ldots S''^2_{n\cdot 12\cdots n-1}}{S^2_1 \, S^2_{2\cdot 1} \ldots S^2_{n\cdot 12\cdots n-1}} - 1.$$

By finding the kth moment of $\frac{|a_{ij}|}{|e_{ij}|}$ Wilks[4] has shown that the distribution of $Y = \frac{|a_{ij}|}{|e_{ij}|}$ is given by

$$\frac{\Gamma\frac{N}{2}}{\Gamma\frac{N-n}{2}\,\Gamma\frac{n}{2}} \cdot Y^{\frac{N-n}{2}-1} (1-Y)^{\frac{n}{2}-1} \, dY$$

with a range from 0 to 1.

We will now get the distribution of $Z_1 Z_2 \ldots\ldots Z_n$, where

$$Z_r = \frac{S^2_{r\cdot 12\cdots r-1}}{S^2_{r\cdot 12\cdots r-1} + [(\bar{x}_r - m_r) - \beta_{1r\cdot 23\cdots r-1}(\bar{x}_1 - m_1) - \beta_{2r\cdot 13\cdots r-1}(\bar{x}_2 - m_2) \ldots \beta_{r-1\cdot r\cdot 12\cdots r-2}(\bar{x}_{r-1} - m_{r-1})]^2}$$

The β's are the population values of the partial regression coefficients.

The distributions of $X_r = \frac{N S^2_{r\cdot 12\cdots r-1}}{\sigma^2_{r\cdot 12\cdots r\cdot 1}}$ and

$$Y_r = \frac{N\,[\bar{x}_r - m_r) - \beta_{1r\cdot 23\ldots r-1}(\bar{x}_1 - m_1) \ldots - \beta_{r-1\cdot 12\ldots r-2}(\bar{x}_{r-1} - m_{r-1})]^2}{\sigma^2_{r\cdot 12\ldots r-1}}$$

are given by

$$K_r \cdot \text{Exp.} - X_r \cdot X_r^{\frac{N-r-2}{2}}\, dX_r \text{ and}$$

$$C_r \cdot \text{Exp.} - Y_r \cdot Y_r^{-\frac{1}{2}}\, dY_r.$$

$\sigma^2_{r\cdot 12\ldots r-1}$ stands for the residual variance of the population corresponding to $S^2_{r\cdot 12\ldots r-1}$.

Now $X_1, X_2, \ldots\ldots X_n$ and $Y_1, Y_2 \ldots\ldots Y_n$ are independent of one another and hence the kth moment of $Z_1 Z_2 \ldots\ldots Z_n = \left(\frac{X_1}{X_1+Y_1}\right)\left(\frac{X_2}{X_2+Y_2}\right) \ldots\ldots \left(\frac{X_n}{X_n+Y_n}\right)$ is the product of the kth moments of $\left(\frac{X_1}{X_1+Y_1}\right)$; $\left(\frac{X_2}{X_2+Y_2}\right)$; ..... $\left(\frac{X_n}{X_n+Y_n}\right)$. The kth moment of $\frac{X_1}{X_1+Y_1}$ is equal to

$$\frac{1}{\Gamma\frac{N-1}{2}\Gamma\frac{1}{2}} \int_0^\infty \int_0^\infty e^{-(X_1+Y_1)} \times \frac{X_1^{\frac{N-3}{2}+k}}{(X_1+Y_1)^k} \cdot Y^{-\frac{1}{2}}\, dX_1\, dY_1.$$

Using the integral

$$\int_0^\infty \int_0^\infty \phi(x+y)\, x^\alpha y^\beta\, dx\, dy = \frac{\Gamma\alpha+1\ \Gamma\beta+1}{\Gamma\alpha+\beta+2} \int_0^\infty \phi(z)\, z^{\alpha+\beta+1}\, dz,$$

it can be shown that the kth moment of $\frac{X_1}{X_1+Y_1}$ is equal to

$$\frac{\Gamma\frac{N-1}{2}+k\ \Gamma\frac{N}{2}}{\Gamma\frac{N-1}{2}\Gamma\frac{N}{2}+k}.$$

Similarly the moments of $\frac{X_2}{X_2+Y_2} \cdots \frac{X_n}{X_n+Y_n}$ can be calculated and the product of these moments is

$$\frac{\Gamma\frac{N}{2}\ \Gamma\frac{N-n}{2}+k}{\Gamma\frac{N}{2}+k\ \Gamma\frac{N-n}{2}}.$$

It is obvious that the kth moment of $\frac{|a_{ij}|}{|e_{ij}|}$ is the same as $Z_1 Z_2 \ldots Z_n$. Hence the distributions also are the same.

It is now worth while to examine the exact difference between $\frac{|a_{ij}|}{|e_{ij}|}$ and $Z_1 Z_2 \ldots Z_n$.

We have already seen that

$$\frac{|a_{ij}|}{|e_{ij}|} = \frac{S^2_1 S^2_{2\cdot 1} \ldots S^2_{n\cdot 12\ldots n-1}}{S''_1 S''_{2\cdot 1} \ldots S''_{n\cdot 12\ldots n-1}} \text{ and } Z_1 Z_2 \ldots Z_n$$

can be considered to be equal to

$$\frac{S^2_1 S^2_{2\cdot 1} \ldots S^2_{n\cdot 12\ldots n-1}}{S''_1 S''_{2\cdot 1} \ldots S''_{n\cdot 12\ldots n-1}},$$

where

$$S''_{r\cdot 2\ldots r-1} = S^2_{r\cdot 2\ldots r-1} + \{(\bar{x}_r - m_r) - \beta_{r\cdot 2\ldots r-1}(\bar{x}_1 - m_1) - \beta_{r\cdot 13\ldots r-1}(\bar{x}_2 - m_2) - \ldots\ldots \beta_{r-1\cdot 12\ldots r-2}(\bar{x}_{r-1} - m_{r-1})\}^2.$$

It is obvious that the difference between $\frac{|a_{ij}|}{|e_{ij}|}$ and $Z_1 Z_2 \ldots Z_n$ lies in the fact that while S''s are calculated on the basis of sample regression coefficients, S"'s are based on the regression coefficients of the population.

The distribution of either T^2 or $Z_1\ Z_2 \ldots Z_n$ can be used to test whether two samples belong to one and the same multivariate population. If the sizes of the samples are N_1 and N_2,

$$Z_r = \frac{S^2_{r\cdot 12\ldots r-1}}{S^2_{r\cdot 12\ldots r-1} + \frac{N_1 N_2}{(N_1+N_2)^2}\{(\bar{x}''_r - \bar{x}'_r) - \beta_{1r\cdot 2\ldots r-1}(\bar{x}''_1 - \bar{x}'_1) - \ldots \beta_{r-1\cdot r\,12\ldots r-2}(\bar{x}''_{r-1} - \bar{x}'_{r-1})\}^2}.$$

Here $S^2_{r\cdot 12\ldots\ldots r-1}$ is the pooled estimate of the variances within the two samples together and $\bar{x}''_r$ and $\bar{x}'_r$ are the means of the samples. The distribution of Y in this case is obtained by substituting $N_1 + N_2 - 1$ for N in the distribution given by Wilks.

If two samples belong to populations with different means and the same variances and covariances, it can be shown that the values corresponding to $Z_1\ Z_2 \ldots\ Z_n$ discussed above is given by a similar expression

$$Z_1' Z_2' \ldots\ldots\ldots Z_n',$$

where

$$Z'_r = \frac{S^2_{r\cdot 12\ldots r-1}}{S^2_{r\cdot 12\ldots r-1} + \frac{N_1 N_2}{(N_1+N_2)^2}[\{(\bar{x}''_r - \bar{x}'_r) - (m''_r - m'_r)\} - \beta_{1r\cdot 2\ldots r-1}\{(\bar{x}_1'' - \bar{x}'_1) - (m''_1 - m'_1)\} - \ldots\ \beta_{r-1\cdot r\,12\ldots r-2} \times \{(\bar{x}''_{r-1} - \bar{x}'_{r-1}) - (m''_{r-1} - m'_{r-1})\}]^2}.$$

The distribution of this quantity is identical with that of $Z_1\ Z_2 \ldots\ldots Z_n$. It can be shown that a relation similar to that between T^2 and $Z_1 Z_2 \ldots Z_n$ exists between Bose and Roy's[5] D^2-statistic when $\Delta \neq 0$ and $Z_1' Z_2' \ldots Z_n'$, with the difference that the distribution of $Z_1' Z_2' \ldots Z_n'$ is far simpler than that of the D^2-statistic.

It may, further, be pointed out that the distribution of D^2 involves Δ^2. $Z_1' Z_2' \ldots\ldots Z_n'$ can be calculated if all the quantities necessary for calculating Δ^2 are known and hence it is immaterial whether we use D^2-statistic or $Z_1' Z_2' \ldots Z_n'$. But as the distribution of the latter expresssion is simpler and can be had from the existing tables, the probability of observed differences between the means of two samples from two populations with given

differences between their means for the different variates can be easily obtained.

Imperial Agric. Res. Institute,
New Delhi, P. V. KRISHNA IYER.
October 3, 1944.

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'*ZERO ORDER*' REACTIONS UNDER ELECTRIC DISCHARGE

1. As ordinarily formulated the law of Mass Action implies thermal changes. Its wider significance is, however, indicated by the fact that the Mass law expressions hold for the kinetics of photochemical, especially photocatalytic reactions; spontaneous recombination of opposite ions in gases; radioactive changes including both consecutive and Wegscheider type simultaneous reactions; equilibria in the ionisation of weak electrolytes and of others at low concentrations; decrease of the micellar 'primaries' as envisaged in Smoluchowski's theory of coagulation, etc.[1] It is now suggested that the progress of a discharge reaction may also be considered, under certain conditions, from the standpoint of the Mass law.

2. For a reaction of the nth order, it is shewn that,

$$k = \frac{1}{t\,(n-1)} \left\{ (a-x)^{-(n-1)} - a^{-(n-1)} \right\} \qquad \text{(i)}$$

$$= \frac{a^{-(n-1)}}{t\,(n-1)} \left\{ \left(1 - \frac{x}{a}\right)^{-(n-1)} - 1 \right\} \qquad \text{(ii)}$$

where the various symbols have their familiar significance. If now t is such that the corresponding fractional change x/a is small, we can write to a sufficient approximation,

$$k = \frac{1}{t\,(n-1)\,a^{(n-1)}} \left\{ 1 + (n-1)\,\frac{x}{a} - 1 \right\} \qquad \text{(iii)}$$

$$t = \frac{1}{k.a^{(n-1)}} \cdot \frac{x}{a}\,; \quad \frac{x}{a} = k.t.a^{(n-1)} \qquad \text{(iv)}$$

(iv) may also be obtained directly from the Mas law expression for the average velocity $\Delta x/\Delta t = k(a-x)^n$; the simplifying approximation giving (iii) may then be introduced. (iv) leads to the familiar method of determining the 'order' of a reaction from observation of the influence of the initial concentration a upon time t corresponding to given x/a, and *vice versa*. *The derivation* (i-iv) not found in the literature, gives a theoretical basis for this method; its applicability is limited by conditions implied in the approximation leading to (iii). In actual practice x/a as high as 0·5 would appear to be permissible.

3. Putting $n = 0$ in (iv) yields the empirical test for a 'zero order' reaction. It is that for a given t, x/a increases directly as, or what is the same thing, that the absolute rate of change is independent of, a. These reactions occur almost entirely on either the walls of the reaction vessel or/and on a catalyst surface;[2] loss in this amount of the reactant material during reaction is made good by adsorption from the homogeneous phase.[2] Changes in the concentration of the latter will not affect sensibly the amount adsorbed and, therefore, the corresponding nett rate of the reaction.[2]

The frequent occurrence under electrical discharge of the 'clean up' and allied phenomena suggest that the type of effects leading to consequences as indicated above might well obtain in discharge reactions. It is instructive here to cite certain results on the newly observed light-effect,[1,6,3,4,7] *viz.*, Δi an instantaneous and reversible change on exposure to an *external* radiation of the discharge current i. It is found that Δi varies appreciably due to 'ageing' under the discharge,[1,3,4] and, that its time-rate depends markedly on the nature of any pre-treatment to which the discharge tube was subjected.[1] By giving appropriate coats on the container walls, it has been possible not only to alter very markedly the magnitude but the *sign* of the light-effect.[1] These results point to a variable adsorption-like layer as an important determinant of the phenomenon.[1,5] The subsequent observation of a periodic effect[1,5] in the nitrous oxide, hydrogen interaction under discharge showing not only a rhythmic variation of the rate of change but (during certain stages) of its direction is easily explicable, on the assumption of an intermittent formation and break up of a layer on the electrodes, producing a variation of the surface gradient, of the 'threshold potential' V_m[1,6,7,5] and, therefore, of the corresponding electrical quantities during the reaction as observed.[1,6,7,5] It follows, therefore, that (*a*) a large surface : volume ratio as in an ozoniser type discharge tube would favour the occurrence of such a periodic effect and that (*b*) this surface action leading to 'zero order' changes need not necessarily be confined to ordinary adsorption, *viz.*, that produced in absence of an external electrical field. Work is in progress to investigate the limits of the validity of (*a*); (*b*) is to be anticipated from general considerations of the discharge phenomena.

4. Alternatively to, or what is more likely, simultaneously with the mechanism considered in para 3, the change may be caused photochemically by the *internal* radiation produced in the reaction space under discharge. It is considered that adsorption as in para 3 of the reactant material and its activation in the discharge increases its optical absorption. This last towards the *internal* radiation may be total or feeble; the order of the corresponding change, therefore, would be zero or one respectively.

Department of Chemistry,
Benares Hindu University, S. S. JOSHI.
February 9, 1945.

1. Joshi, *Pres Address, Indian Sci. Cong. Chem. Sec.*, 1943. 2. *Cf.* Hinshelwood, *Kinetics of Chemical Change in Gaseous Systems* (Oxford). 3. Joshi and Deshmukh, *Nature*, 1941, **147**, 806. 4. Deo, *Proc. Indian Acad.*, 1945, **A. 21**, 76–80. 5. Joshi and Deshmukh, *Nature*, 1945, **155**, 483. 6. Joshi, *Curr. Sci.*, 1939, **8**, 48. 7. —, *Nature*, 1944, **154**, 147.

NEUTRALISATION OF SPACE-CHARGE OF HOT METALS BY POSITIVE IONS OF POTASSIUM

In previous experiments[1] it was observed that high velocity positive ions of mercury did not have any effect on the Space-Charge of a hot filament and thus no change in its thermionic emission was detected when a beam of mercury positive ions was fired on it. The negative results in these experiments were probably due to the low intensity of the Mercury positive ion beam used.

In the present work investigations have been carried out with slow Potassium positive ions of much greater intensity. The apparatus consisted of a thin Tungsten filament surrounded by a Nickel cylinder which served to collect the thermionic electrons from it. The filament was heated by the secondary of a low tension transformer. A very fine hole was made in the cylinder opposite the filament and a plate was placed outside the cylinder to collect the electrons issuing out of the fine hole. This electron current was measured with a galvanometer of the sensitivity of 10^{-10} amps./mm. The thermionic current to the cylinder was measured with a milliammeter. A beam of positive ions of Potassium was fired on the filament and the variations in the electron current to the plate was observed in the galvanometer for varying intensity of the beam of positive ions of different velocities. The observations were taken at different temperatures of the filament. The results shown in Figs. (1) and (2) are typical of a large number of curves obtained.

The curves in Fig. 1 show that:—

(1) The thermionic emission from the filament at a particular temperature rises almost linearly with the intensity of the positive ion beam incident on the filament.

(2) The increase in the thermionic emission at a particular temperature of the filament is less with ions of greater velocities for the same intensity of the beam.

The curves in Fig. 2 show that:—

(3) For a particular intensity and velocity of positive ions the relative increase in the thermionic emission falls off with increasing temperature of the filament.

The temperature of the filament in these experiments was always below that at which saturation current would be obtained with the anode potential used here, *viz.*, 10 volts.

Details of the experiments will be published elsewhere.

Physics Department, Muslim University, Aligarh, *May*, 2, 1945.

R. M. CHAUDHRI.
ANIS AHMAD.

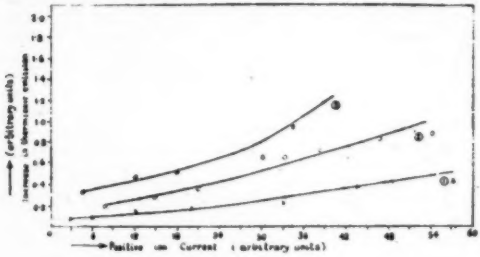

FIG. 1

Filament heating current = 4·4 (arbitrary units)
Anode Voltage = 10·0 volts
Positive ion accelerating voltage:—
Curve 1, 8·0 volts.
Curve 2, 4·0 volts.
Curve 3, 2·0 volts.

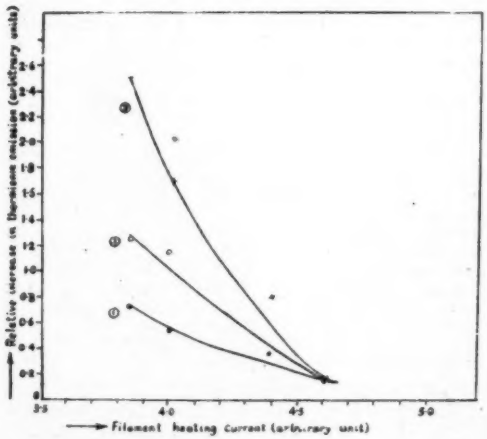

FIG. 2

Positive ion current = 42·0 (arbitrary units)
Anode voltage = 10·0 volts
Positive ion accelerating voltage:—
Curve 1, 8·0 volts.
Curve 2, 4·0 volts.
Curve 3, 2·0 volts.

1. Chaudhri, R. M., Nawaz, S. M., and Aslam, M., *Proceedings, National Institute of Sciences of India*, 1939, **5**, 3, 359.

ON A SPECIES OF SCHISTOSOMA RECORDED FOR THE FIRST TIME FROM THE ELEPHANT

In the course of examination of helminths from a cow-elephant which died recently in the 'Topslip' area of the Coimbatore District, the author was fortunate to meet with *Schistosomes* from the liver. Since there is no record of *Schistosomes* in the elephant either in India or elsewhere in the world, as far as known, opportunity is taken to place this on record.

The collection consisted of about a hundred worms inclusive of males and females and in a bad state of preservation as they were all picked up, dead. Attempts at a morphological study indicate that the specimen differs from all known species of the genus. Though a correct identity of the worm together with a morphological description will form the matter for a future communication the following general features noticed are mentioned here:—

Males: Fairly large sized; suckers fleshy and well-developed; cuticle covered with coarse tubercles on the dorsal surface; edges

prominently inturned, forming a well-defined gynæcophoral canal; testes as many as fifty; arranged in a string, from behind the ventral sucker; intestinal cæca unite very near the hind end.

Females: Long and slender; uterus has a single ovum, shaped a longish oval with a short, abrupt, spine at one end and covered with longitudinal ridges or rugæ on the shell. Intestinal cæca have a very zigzag course, unite more than twice and end in a short common cæcum.

The Madras Veterinary College,
Madras, S. V. MUDALIAR.
May 28, 1945.

THE "BELLIER FIGURE" AS AN ANALYTICAL CONSTANT OF VEGETABLE OILS AND ITS USE IN DETECTING ADULTERATION IN THEM

BELLIER'S qualitative test for arachis oil in olive oil and its modification by Franz and Adler making the test quantitative by determining the temperature at which a turbidity is first produced are quoted by Evers.[1] This test has been adopted by H. Hawley[2] in this laboratory for detecting and estimating the amount of arachis oil in sesame (gingelly, til) oil which is very commonly adulterated, and has been extended to some other common edible oils. It has proved a rapid and fairly accurate test in the analysis of a number of oils received in this laboratory under the Madras Food Adulteration Act, *e.g.*, sesame, coconut, safflower and nigerseed oils. In fact, the turbidity temperature determined under strictly controlled conditions, as given below, is remarkably constant for a particular oil and in the writer's opinion, should rank as an analytical constant in the routine examination of oils. The writer proposes to call this the "Bellier figure".

The Bellier figure is determined as follows:—One ml. of the oil (Garratt[3] states that for this determination the oil should be accurately measured or better weighed, i.e., 0·92 gm. being used. But the writer finds that there is no change in the Bellier figure even when the quantity of the oil varies by as much as 100 mg. and reproducible values can be obtained by pipetting out 1 ml.) is pipetted into a 250 ml. flat-bottomed flask and 5 ml. of 1·5 N alcoholic potash (15 ml. of 10 N potash solution made up to 100 ml. with redistilled rectified spirit of 90 per cent.) added. The mixture is heated under a reflux condenser by a tiny flame for five minutes and allowed to cool. It is then neutralized by 1·5 ml. dilute acetic acid (226 ml. glacial acetic acid of 17·3 N diluted to 500 ml. with distilled water). Lüers[4] recommends the addition of an extra three drops of glacial acetic acid in addition to the quantity prescribed by Franz and Adler.[5] The above dilution of glacial acetic acid ensures the necessary strength as recommended by Lüers. The resulting solution has a pH of 5·4. Fifty ml. of 70 per cent. (by volume) alcohol is then added. The strength of the alcohol must be accurately adjusted. It has a S.G. at 60°/60° F. of 0·8900. If a turbidity appears immediately, the contents are warmed on a water-bath till it disappears. Thirty to forty ml. of the solution is then transferred to a large test-tube fitted with a two-holed rubber cork. Through one of the holes is passed a thermometer having a range of 0-50° C. reading to ½°. Through the other passes a thin glass rod bent at the bottom in the form of a circle to stir the solution. The test-tube is cooled in ice-water and stirred continuously. It is frequently taken out of the bath to avoid local supercooling and the temperature at which a distinct opalescence is formed gives the Bellier figure. The figure is checked by warming till the turbidity disappears and recooling.

The saponification and iodine values have ranges such that the values for two oils sometimes overlap. On the other hand, the Bellier figure is more specific and along with refractive index appears in most cases sufficient to judge the purity of an oil. The Bellier figures and Butyro-refractometer readings of some oils are given in Table I.

TABLE I

Oil	Bellier figure	Butyro refractometer reading at 40° C.
Sesame ..	19–20	59–60
Coconut ..	13–14	35–36
Safflower ..	15–16	64–65
Nigerseed ..	25–26	63–64
Mustard seed ..	24·5*	60·5
Mustard (Rape) ..	27·5*	59·5
Arachis ..	39–40	54–55

* Fig. for one sample of oil extracted from seeds in the laboratory.

Table II gives the Bellier figure of the common edible oils when genuine and when mixed with various percentages of arachis oil given in column A.

TABLE II

A	B				
Percentage of arachis oil by weight	Turbidity temperature (Bellier figure) of the oil mixture containing the percentage of arachis oil shown in col. A and the oil mentioned below to make up the balance.				
	Gingelly	Coconut	Safflower	Niger seed	Mustard seed
..	19—20	13—14	15—16	25 - 26	24—0
10	23—25	19·0	23·0	29·0	28·0
20	27·0	25·0	27·0	31·5	31·0
30	30·0	28·5	30·5	33·5	31·5
40	32·0	32·5	32·5	34·0	33·0
50	34·0	33·0	34·3	34·5	34·0
60	36·0	34·5	36·0	35·0	35·5
70	37·0	36·0	37·5	37·0	37·0
80	38·5	37·0	39·0	38·5	38·6
90	39·5	38·0	39·5	39·0	39·0
100	40·0	40·0	40·0	40·0	40·0

Fig. 1 shows the curves obtained when the Bellier figures are plotted against the percentages of arachis oil.

An inspection of the curve will show that although the Bellier figures increase with the percentage of arachis oil in the mixture, the increase is not proportional and that there is a steep rise for percentages of arachis oil below 25 but when the arachis oil content increases further the Bellier figures rise only slowly to the maximum of 40° C. for arachis oil itself. The percentage of arachis oil in an unknown

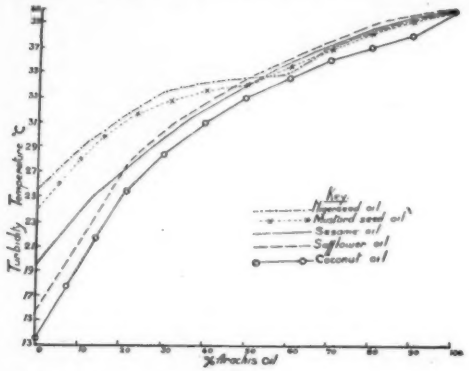

FIG. 1

sample, particularly when the percentage of adulteration does not exceed 50, is given with considerable accuracy by the Bellier figure.

The Bellier figure for genuine buffalo ghee ordinarily falls within the fairly narrow range of 28-30° and that for Vanaspati varies with the nature of the oil from which it was derived. But the values for some unquestionably genuine ghees departed considerably from this range.

My thanks are due to Mr. H. Hawley, Government Analyst, for his criticism, suggestions and encouragement, and to the Surgeon-General with the Government of Madras, for permission to publish this paper in *Current Science*.

King Institute,
Guindy, Madras, S. NARAYANAIER.
April 23, 1945.

1. *Analyst*, 1912, p. 487. 2. *Curr. Sci.*, June 1937. p. 640. 3. *Drugs & Galenicals*, 1937, p. 332. 4. *Abs. Analyst*, 1913, p. 58. 5. *Loc. cit.*

A SCIENTIFIC NEW YEAR'S DAY

SINCE the publication of the above note in *Current Science* of March 1945, 14, 68, it has been brought to my notice that there is nothing really scientific about January 1st being the New Year's Day. The argument was based on the fact that the day of the earth passing through the perihelion of its orbit has of late years been round-about January 1.

As a matter of fact, the date of perihelion is not permanent, and it is only by chance that it, at present, falls around January 1. The average date at the present epoch is January 2.

The mean tropical year, i.e., the time between two successive vernal (or automnal) equinoxes, which determines the cycle of the seasons, is 365·24220 mean solar days. The time between two successive passages of the earth through the perihelion, known as the anomalistic year is, however, slightly longer. The mean anomalistic year has 365·25964 days. Thus the anomalistic year is longer than the tropical by 0·01744 of a day, or about 25 minutes, which makes perihelion come about seven days later in 400 years.

The actual time of perihelion passage fluctuates around its mean position by one or two days owing to slight irregularities in earth's motion and to the arrangement of leap years in our calendar, which will account for its variation between January 1, and January 4, during the period taken into account in the previous note.

Perihelion passage coincided with the winter solstice in about 1300 A.D. It will coincide with the vernal equinox in about 6500 A.D. at its present rate of progress.

The actual time taken by the earth to go round the sun, relative to a star, is the mean sidereal year of 365·25636 mean solar days. This is the most constant of the three types of years, changing by only a second in about 10,000 years. The tropical year changes by about a second in only 200 years.

The tropical year falls short of the sidereal due to precision of the equinoxes, which completes a full cycle in about 25,000 years. The anomalistic year exceeds the sidereal owing to the 'apse line', i.e., the major axis of the earth's elliptical orbit gradually moving forward.

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Lahore, J. B. SETH.
May 18, 1945.

RELATIVE GROWTH PROMOTING POTENCY OF SOME STEROLS ON *CORCYRA CEPHALONICA* STAINT

A FAT-SOLUBLE factor for the growth and pupation of the larvæ of *Corcyra cephalonica* Staint has been shown to be essential; it was, therefore, of interest to determine whether the triglycerides, triolin, tristearin and tripalmitin in any way satisfied the fat-soluble requirement of the insect.

Newly hatched larvæ were fed for ten days on whole jowar and then transferred in weighed batches to the experimental diets. Whole jowar and chloroform-extracted jowar were used as controls. Results are given in Table I. It may be observed from Table I that none of the triglycerides are useful in promoting the growth of the insect larvæ.

On the 21st day the larvæ were transferred from the triglyceride diets to whole jowar. The larvæ were weighed again after 11 days. The results show that the larvæ in spite of their arrested growth, retain their recuperative power and rapidly respond to the whole diet.

Our previous studies strongly suggested that sterols would probably supply the necessary

TABLE I

Average Weight of Ten Larvæ

Diet	Days					
	0	7	14	21	Weight of the larvæ 11 days after the transfer to whole Jowar	
I. Whole Jowar	5·03	24·7	121·88	394·70	Transferred to whole Jowar on 21st day	13 pupæ ; 1 larva
II. Chloroform extracted Jowar (C.E.J.)	5·60	10·68	8·98	8·63		85·48
III. C.E.J. + Triolein	5·32	9·37	8·72	6·90		79·33
IV. C.E.J. + Tripalmitin	5·36	10·85	8·32	6·67		110·91
V. C.E.J. + Tristearin	5·62	9·52	7·77	8·37		94·88

TABLE II

Average Weight of Ten Larvæ

Diet	Days				Remarks
	0	7	14	25	
A. With triolein					
I. Whole Jowar	1·80	16·46	81·50	Most pupated	Some pupated
II. Chloroform extracted jowar (C.E.J.)	1·98	2·46	1·88	No Survivals	No survivals
III. C.E.J. + Cholesterol	1·62	8·96	22·92	128·44	Some pupated
IV. ,, + Sitosterol	1·58	8·00	16·38	62·08	,, ,,
V. ,, + Phytosterol	1·62	9·34	27·78	145·92	No Pupæ
VI. ,, + Calciferol	1·72	2·58	3·72	3·82	,, ,,
B. Without triolein					
I. C.E.J. + Cholesterol	1·62	10·82	36·62	165·92	No pupæ
II. ,, + Sitosterol	1·66	11·54	36·08	122·28	,,
III. ,, + Phytosterol	1·86	11·22	20·64	102·40	,,
IV. ,, + Ergosterol	1·86	8·94	17·82	78·18	,,

TABLE III

Average Weight of Ten Larvæ

Diet	Days			Remarks
	0	18	25	
A. With triolein				
I. Whole Jowar	12·20	200·26	All pupated	All pupated
II. C.E.J. + Cholesterol	14·56	121·48	168·70	No pupæ
III. ,, + Sitosterol	12·84	70·94	136·12	Some pupated
IV. ,, + Phytosterol	13·50	91·14	186·00	Some pupated
V. ,, + Calciferol	15·32	11·58	No survival	—
B. Without triolein				
I. C.E.J. + Cholesterol	23·88	140·58	151·72	Some pupated
II. C.E.J. + Sitosterol	22·14	108·92	168·12	No pupæ
III. C.E.J. + Phytosterol	22·62	155·84	206·00	Some pupated
IV. C.E.J. + Ergosterol	24·02	129·98	170·64	No pupæ

fat-soluble growth requirement of the Corcyra larvæ; experiments were accordingly carried out supplementing the basal diet (chloroform-extracted jowar) with 1 mg./gm. cholesterol, ergosterol, sitosterol, phytosterol and calciferol respectively with and without the addition of triolein (4·28 g./100 g. of chloroform-extracted jowar). Results are given in Tables II and III.

From the above tables it may be seen that the cholesterol, sitosterol, phytosterol and ergosterol can each satisfy the fat-soluble factor requirements of the insect. The addition of triolein does not influence the rate of

growth nor the time required for pupation. Calciferol on the other hand does not support the growth of Corcyra larvæ and appears to exert a toxic effect.

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Bangalore,
June 4, 1945.

ALGEBRA RELATED TO PARTICLES OF SPIN $^3/_2$

ONE of us (B. S. M.) has considered [(1942), referred to here as I], the question of deriving commutation rules for the matrices β appearing in the relativistic wave-equation of a particle of arbitrary spin in the form

$$\partial_\mu \beta_\mu \psi + \varkappa \psi = 0 \qquad (1)$$

of the famous Dirac equation for a particle of spin $\frac{1}{2}$. It was there shown that this problem could be solved by making the new assumption that the spin operator $t_{\mu\nu} = i\, s_{\mu\nu}$ satisfies the condition

$$t_{\mu\nu} = (\beta_\mu, \beta_\nu) \equiv \beta_\mu \beta_\nu - \beta_\nu \beta_\mu \qquad (2)$$

for all spins.

The general commutation valid for all spins can then be written as

$$(\beta_\mu, t_{\nu\rho}) = (\beta_\mu, (\beta_\nu, \beta_\rho)) = \delta_{\mu\nu}\, \beta_\rho - \delta_{\mu\rho}\, \beta_\nu \qquad (3)$$

The special clases of spins $^3/_2$ and 2 were considered in I, and the restricted forms of (3) on the further assumption that the eigenvalues of $s_{\mu\nu}$ for a particle of spin s are s, $s-1$, ..., $-s+1$, $-s$, were also given there [I, (26) and (34)] for these cases.

The imposition of condition (2), while it solves this particular problem of deriving the commutation rules, has also very far-reaching consequences in that it makes wave-equation (1) itself of fundamental importance in obtaining properties of the elementary particles. Bhabha (1945, *a*, *b*, *c*) has recently considered the full implications of the assumption (2) and shown that the problem of finding all irreducible equations of form (1) can be connected with that of finding all irreducible representations of the Lorentz group in five dimensions. He has further shown that, on this theory, a particle of maximum spin n must appear with n different values of the rest-mass if n is an integer, and $n + \frac{1}{2}$ values if n is half an odd integer, the higher values of the rest-mass being simple rational multiples of the lowest value.

On the basis of his new theory Bhabha has considered (1945, *c*) in particular, the two possible equations of the form (1) for a particle of maximum spin $^3/_2$, and indicated, by consideration of the non-relativistic approximation, that the equation given by one of the representations denoted by $R_5(^3/_2, \frac{1}{2})$ may possibly describe the behaviour of the proton. The degree of this representation, *viz.*, 16, and the explicit expression for the same have also been derived by him [*ibid.*, (74) and (76)].

We have independently investigated the algebra generated by the commutation rules for the case of spin $^3/_2$, [(I, (26)] exactly on the pattern given by Kemmer (1939) for the case of spin one (Meson algebra). The investigation is not too laboricus on account of the fact that the algebra becomes the direct-product of two sub-algebras, one being the Dirac algebra of rank 16, and another, which we call the ξ-algebra, of rank 42. Thus there is really no need to count the 672 (16×42) linearly independent quantities generated by the β_μ, I and all powers and products of the β_μ. The dimensionality of the representations is then decided by the relation: $42 = 1^2 + 4^2 + 5^2$ pertaining to the ξ-algebra, and given by (4×1), (4×4), (4×5), *i.e.*, 4, 16 and 20 for the original algebra. Of these the first relates to the case of spin $\frac{1}{2}$ and may be discarded. It can also be shown that the algebra for the case of all half-integral spins is the direct product of the Dirac algebra and an associated ξ-algebra.

The commutation rule for spin $^3/_2$ is likely to prove useful in investigations relating to the above-mentioned theory of Bhabha for the proton, and the associated ξ-algebra which is easier to handle than the original β-algebra might be used in the related calculations. We have also derived the representation matrices for the ξ-algebra in both the representations of orders 16 and 20.

The related results will be published in detail elsewhere.

B. S. MADHAVA RAO.
K. VENKATACHALIENGAR.
V. R. THIRUVENKATACHAR.
Department of Mathematics,
Central College,
Bangalore,
July 20, 1945.

Bhabha, *Curr. Sci.*, **1945**, **14**, 89–90, (*a*); —, *Rev. Mod. Phys.*, **1945** (in course of publication), (*b*); —, *Proc. Ind. Acad. Sci.*, 1945. **21**, 241–64, (*c*). Kemmer, *Proc. Roy. Soc.* A, **1939**, **173**, 91–116. Madhava Rao, *Proc. Ind. Acad. Sci.*, 1942, **15**, 139–47; *J. Mys. Univ.*, **1942**, **3**, 59.

SCIENTIFIC RESEARCH AND INDUSTRY IN U.S.A.

WITH reference to his address on "Scientific Research and Industry in U.S.A.," published in the April 1945 issue of the Journal (*Curr. Sci.*, 1945, **14**, 90), Sir J. C. Ghosh writes to us under date July 9, 1945, that "Some statements which been made on the basis of information which was given to me when I was in America regarding the oil fields in Bahrein Island and in Arabia. My friend, Mr. P. Evans, of the Burmah Oil Co., informs me that some of the statements made there may not be quite accurate."—ED.

REVIEWS

Plastics for Production. By Paul I. Smith. (Chapman & Hall, Ltd., London, W.C. 2), Pp. viii + 180. Price 12*sh*. 6*d*. net.

The development of the chemistry and technology of plastics has received a tremendous stimulus under the stress of a war-time economy which brought about a crisis in the supply of a variety of strategic materials, particularly metals and natural rubber. In the process of conserving these valuable raw materials, the rich and fertile field of plastics has been intensively explored; this has resulted not only in the finding of new and better plastics but also in the evolution of new production methods. The urgency and speed with which munitions of war had to be forged in quantity gave unlimited scope for the plastics to display their eminent suitability for and meet essential requirements of modern production methods.

The volume under review gives in outline the factors which determine the choice of a plastic and describes the entire range of plastics at present available. The succeeding few chapters are devoted to a critical survey of the plastics for electrical insulation, chemical resistance and mechanical strength. A very valuable feature of the book consists of the technical data which would be helpful in determining the suitability of a plastic for a given purpose.

"To those who consider that the plastics industry offers many lucrative opportunities for employment and investment of capital after the war this book will, it is hoped, act as a guide revealing within the limitations imposed by security, the main types of materials available at the present time and their suitability or otherwise for industrial purposes. In addition, I have tried to give brief glimpses of the 'shape of things to come.'"

The subject-matter is presented on a broad canvas through which the essential principles of production could be easily pictured. It is a volume which would be welcomed not only by the production engineer and the business executive but also by those who wish to keep abreast of the technological developments in the field of plastics.

Hay Fever Plants. By Roger P. Wodehouse. (Chronica Botanica Co., Waltham, Mass., U.S.A.; Macmillan & Co., Calcutta), 1945. Pp. 245. Price $4.75.

There is an element of scientific romance in this book. In the companion volume of Prof. Erdlmann we come to know the prominence attached in recent times to analytical studies on pollen in so far as they aid in the interpretation of such phenomena as peat-formation, geologic formation of areas, geographical distributional frequency of past and present vegetation, its value in systematics and above all, in the production of honey. But, that pollen grains should be the subject of study from this entirely new angle is an example of new pathways in scientific thought.

Pollen grains—which were regarded as innocuous and intended only for plant reproduction—should yet have an additional intrinsic medical worth too, is indeed, a strange revelation, and increasing importance is attached to the study of this subject in recent times, attention being paid to it by the Botanist and the Medical man alike. The volume under review is a testimony to its present position in the scientific pursuit of strange and new fields concerned with human welfare. The aim of the author is rightly said in the preface to be "to interpret the botanical facts of hay-fever in terms of their clinical significance". In this engaging volume of 245 pages, we are introduced to the subject in a simple and suggestive way and are presented with an immense array of facts of great biological bearing. Nothing that is of note escapes the attention of the writer or that of the reader. With appropriateness, the book is divided into two portions—the Botanical and the Clinical. In the former is given a direct and simple approach to the subject—the flower and the pollen. Then follow the characteristics of the pollen,—buoyancy, abundance and allergic toxicity—which cause hay-fever. The techniques of laboratory and field methods of collection, culture, observation, diagnosis and record of pollen are described in detail. Then begins a systematic enumeration of plants whose pollen occasions hay-fever. At first they relate to Gymnosperms. A succinct account of various plant species, their taxonomy, and distribution, together with figures of plants and their pollen makes very informative reading. Only few of the Gymnosperms produce hay-fever-causing pollen.

The next chapters, larger in size and in treatment, relate to Angiosperms and it is evident that the majority of plants causing hay-fever are among the species of flowering plants. These 130 pages comprise the main bulwark of the author and provide us with the best botanical account of all flowering plants responsible for this clinical phenomenon. Here are included ten phyla of Monocots, the bulk of treatment relating to grasses, both on account of their productivity and similarity of pollen, in causing hay-fever. Among monocots they constitute the main plants causing contamination and spread of this allergic disturbance. On equal footing stand the Dicots. The treatment of twenty-two families of various plant species, in all their aspects, is masterly. In common with the above, a cumulative and clear account of their description, diagnosis, systematics, and distribution, is without dissent, the most holding portion of the book. It is noteworthy, however, that among Dicots, the Compositæ have the largest number of plants causing

hay-fever and accordingly, occupy greater space and treatment. The scientific approach and scholarship of treatment coupled with a limpid style and popular appeal give a most balanced and dignified bearing to the book. The utility of the book is enhanced by providing the reader with a careful and comprehensive bibliography, a useful glossary, excellent sketches and appropriate maps. The book is a notable addition to our knowledge in this new field.

The Chronica Botanica Co. must be singled out for special mention in this connection. Amidst the turmoil of war, this Company has striven to place before the public a galaxy of sumptuous volumes in Plant Sciences. The volume under review reflects the same seductive style, the familiar format, excellent get-up and above all, stolid scholarship. K. V. S.

Life and Work of John Tyndall. By Professor A. S. Eve, F.R.S., and C. H. Creasey, O.B.E (Macmillan & Co., Ltd., London), 1945. Pp. xxxii + 404. Price 21 *sh.* net.

"But, my Lords and Gentlemen, the hardest climb, by far that I have ever accomplished, was that from the banks of the Barrow to the banks of the Thames—from the modest Irish roof under which I was born to Willis's Rooms Here I have reached my mountain-top, and you—God bless you!—have given me a bumper which no scientific climber ever before enjoyed." The biography of such a man of Science of the Victorian era who lived among giants like Darwin, Faraday, Kelvin and Maxwell ought to be interesting.

Born in 1820 as the son of a sergeant in the Irish constabulary, he had a varied early career as a surveyor and school master until in 1848 he went to the University of Marburg to work under Prof. Bunsen. That probably was the turning point in his life. In 1853 he became the Professor of Natural History at the Royal Institution and eventually succeeded Faraday as the Director of the Laboratory.

For thirty-five years not only "did he add to human knowledge by his investigations, but he expounded the knowledge for the benefit of all who could hear or cared to read". In his own day his fame rested more on his skill as a lecturer and writer for, it is perhaps true that he made no outstanding discovery. After all, as Sir John Pollock put it: "The example of straightforward seeking of the truth and endeavour to do one's best work without fear of consequence is far more important to most of us, than the precise amount which one has added to the sum of human knowledge."

Logical pursuit of truth took Tyndall from physics to metaphysics and unlike many who keep their science and religion absolutely separate, untroubled by the incongruities between them, he touched upon debatable problems in his Belfast Address to the British Association. Science made him an agnostic and he tried to see beyond natural phenomena that all-powerful and all-pervading something which he could not comprehend. "He looked through Nature up to Nature's God."

Tyndall died in 1893 and the rapid advances in Science we see to-day have not only provided opportunities for the curious to know much more science than Tyndall ever knew, but have also made individuals not indispensable.

And yet, the *Life of John Tyndall* is interesting to read and would have been much more attractive if not so voluminous.

M. K. SUBRAMANIAM.

Co-operative Electrical Research—1944 E.R.A. Publication.

Co-operation between technical experts and others concerned with the live problems of the electrical industry was almost unknown in England before the last war, and no organization existed to secure it apart from certain activities of the British Standards Institution and the Institution of Electrical Engineers. The war gave an immense stimulus to organized research and the E.R.A. took its birth in 1917 as a result of the co-operative effort of the Government (through the department of Industrial Research), the Institution of Electrical Engineers, the British Electrical and Allied Manufacturers' Association (B.E.A.M.A.), the electric supply organizations, and large consumers of manufactured products.

At first the means at the command of the E.R.A. were very moderate and left much to be desired, only meagre contributions being made towards its expenditure (which was roughly a little over £10,000) by the Government, the B.E.A.M.A., and the I.E.E. For a good many years the tasks of the Association had to be undertaken without any special laboratory; and existing facilities for experimental investigations in the laboratories of the manufacturing concerns, the power companies, the Universities and the N.P.L. were being utilized; but by 1935 the need for further facilities became urgent and the Association set up its own laboratory at Perivale.

Even during the short period of its existence, the work of the E.R.A. has been of immense help to the electric supply organizations, the electrical manufacturing industry, and the consumer alike, not to speak of its great importance in the country's war effort. It has served as the principal medium for co-ordination of research in many fields such as problems connected with (1) Power station efficiency, (2) Transmission of Electricity, (3) Electric supply, (4) Surge phenomena, (5) Transformers, (6) Switchgear, (7) Insulation, (8) Interference with communications, (9) Rural electrification and (10) Fire-fighting. The scope of research and the pressure upon the resources of the Association have increased so rapidly (the present expenditure of the Association is over £100,000 per annum) that the problem of providing further facilities and building up staff to undertake the researches needed for the post-war reconstruction has become most urgent. The E.R.A. has, therefore, decided to put up a new laboratory at Leatherhead immediately.

Judging from the magnificent record of work turned out so far the Association has more than justified itself and its activities during the post-war period would undoubtedly be even greater.

It is hoped that India would emulate the illustrious example set by England in this respect and would soon take steps for the establishment of an organisation on the lines of the E.R.A. which would be extremely valuable in post-war development.

H. N. RAMACHANDRA RAO.

Survey of India, Geodetic Report, 1940. Price Rs. 2 or 3 *sh.*

This volume has been compiled by the War Survey Research Institute, which was formed in August 1943 and has been responsible for geodetic matters. It contains the results of investigations carried out by the Survey of India.

High precision levelling was carried out in certain portions in Orissa, C.P., and Madras. Discrepancies between the old and new heights of bench marks are given.

Both components of the deviation of the vertical were measured in 98 stations in the Punjab, Baluchistan and N.W.F.P., the object of the programme being to provide a map of the Geoid in N.W. India.

Gravity observations were made at fifteen stations in South Burma and one station in Andaman Islands. The total number of gravity stations in India has been increased to 564. Anomalies in gravity due to different causes are considered. Crustul structure lines have been drawn in the light of these results. It is inferred that the downwarp lies over the Andaman Islands and extends to Sumatra.

Of special interest is the study of the variation of latitude observations at Agra during the years 1937-40. The results show an unusually large amplitude of about one second as found at Dehra Dun during 1930-33.

Detailed discussions on various heads could not obviously be given on account of the limited time at the disposal of those in charge of the publication. The Geodetic Branch must be congratulated on the large amount of useful information collected during 1939-40 and published in this Report.

S. R. R.

Race and Cultures in India. By D. N. Majumdar. (Kitabistan, Allahabad), 1945. Pp. 299. Price Rs. 5-4-0.

Dr. Majumdar's industry and enthusiasm are both praiseworthy. In this book which, I think, is his first effort in popular writing, he maintains his liveliness and command of facts on tribal life. The benefits to the nation from a wider appreciation of some commonplaces of anthropology will indeed be out of all proportion to the cost in money and effort required in getting this knowledge transmitted to the public. I am in entire agreement with Dr. Majumdar in believing that several of our communal and regional jealousies will automatically vanish if the leaders of factions, and through them the masses, can be made to understand the meaning and implications of race and culture (language being part of culture in its wider sense). The anthropologist is not alone in putting forth this view—for he would then be denigrated as trying to sell his own wares; fortunately for the country, administrators, such as Sir Theodore Tasker who invited Dr. Majumdar to deliver a course of lectures in anthropology to the I.C.S. probationers and minor chiefs at the Dehra Dun camp, and several social workers and publicists who met recently to discuss the problems of the aborigines, are beginning to realise the value of anthropology in the administration of backward areas. This popular work of Dr. Majumdar's will give the busy man of affairs an idea of the problems facing the tribal and exterior sections of our population and, at the same time, help him to get an insight into their culture from which the so-called higher cultures of our land have developed. The book is a mine of information which the reader is not likely to come across in the usual course.

A. AIYAPPAN.

SCIENCE NOTES AND NEWS

Supply of "H.S." and "Specpure" Substances

The use of the spectrograph for the detection and determination of metallic elements in all kinds of materials has increased considerably in recent years. This has necessitated a demand for extremely pure elements, oxides and salts to serve as standards. Messrs. Adam Hilger, Ltd., London, have been largely responsible for the supply of such standards. About 1922, they started supplying "H.S." substances, the preparation and analysis being in the able hands of their consultant, Dr. S. Judd Lewis. In 1932, with the help again of Dr. Lewis, they introduced the "Specpure" series of "ratio powders", "ratio solutions" and pure salts. From a communication sent to us by Messrs. Adam Hilger, Ltd., we understand that, to cope with the growing demand for such substances, they have entered into an agreement with Messrs. Johnson, Matthey and Co., Ltd. Dr. S. Judd Lewis has been engaged as consultant by the latter. The agreement provides that future sales of spectroscopically standardized substances shall be made only by Messrs. Johnson, Matthey and Co., Ltd., from their Head Office at 73/83, Hatton Garden, London, E.C. 1.

In a recent article in the *Indian Medical Association Journal* ((37, 344), Chen, *et al.*, reports the successful treatment of fourteen instances of cyanide poisoning as a result of the use of combined treatment. The procedure consisted of the following three steps: (1) inhalation of amyl nitrite for 15 to 30 seconds each minute while steps (2) and (3) are being prepared; (2) injection of 10 c.c. of 3 per cent. sodium nitrite solution, intravenously, at the rate of 2·5 to 5 c.c. per minute; (3) using the same needle in the same or another vein, if

desired, inject 50 c.c. of 25 per cent. sodium thiosulphate solution. If the symptoms of cyanide poisoning return, steps 2 and 3 should be repeated, reducing the dose of each solution to one-half the stated amount. Speed in treatment is paramount, and artificial respiration should be administered, if indicated, to restore breathing. If the cyanide has been ingested, gastric lavage should be performed. The authors suggest that a treatment kit, containing proper-gauge needles and ampoules with the solutions be kept in readiness at all times wherever these hazardous substances are employed.

—(*Merck Report, April* 1945)

The recent decision of the British Empire Leprosy Relief Association to collect £210,000 "for use in the plan to exterminate leprosy within the British Empire" is laudable. For, in the British Empire there are 2,000,000 lepers!—more than half the world population of such unfortunates. It appears as if the leper problem is at last getting the attention it deserves (*cf. Curr. Sci.*, June 1945).

From time immemorial the leper has been an outcast and the fight against the scourge was half-hearted owing to the firm belief that the disease was incurable. Dr. Muir now holds out the hope of a cure if the disease is diagnosed sufficiently early and treated in time. The ancient Atreyan remedy, Hydnocarpus oil is now administered intra-muscularly as sodium-hydnocarpate and it is claimed that it destroys the lepra bacilli.

Experience has proved that compulsory isolation is impracticable and hence more stress is now laid on voluntary admissions to sanatoria where the patients are enabled to lead a normal life with their families. It appears as if this changed outlook has infused some confidence into the lepers themselves, for it is stated: "For the last ten years, more than fifty per cent. of the patients from the model leprosy sanatorium at Ngomahuru in Southern Rhodesia, have been discharged yearly as cured, and this percentage is steadily rising; more patients are being discharged than taken in."

"Leprosy is not as contagious as is generally believed. Only about one in four lepers is in that condition, and the danger is small provided certain precautionary measures are taken. *The real danger of contagion is from those who seek to hide their disease.*"

M. K. S.

The Academic Press Inc., of New York, U.S.A., will be soon publishing a *Journal of Colloid Science*, and the first issue of the Journal is expected to come out in January 1946. The following aspects of colloid science will be dealt with:—

I. *Fundamentals*: Physics, Physical Chemistry and Chemistry of Colloids and Surfaces. II. *Applications*: (1) Industry, *e.g.*, Plastics, Soaps, Photography, Food and Flotations, Emulsions. (2) Biology, Protoplasma, Cell-structure.

The Journal will be issued under the auspices of a distinguished Editorial Board and a Consultative Committee, both international in character.

Papers from India may be sent for consideration to Prof. J. N. Mukherjee, C.B.E., D.SC., University College of Science and Technology, 92, Upper Circular Road, Calcutta.

MAGNETIC NOTES

Magnetic conditions during April 1945 were slightly more disturbed than in the previous month. There were 14 *quiet* days, 14 days of *slight* disturbance and 2 days of *moderate* disturbance as against 12 quiet days, 17 days of slight disturbance and 1 of great disturbance during the same month last year.

The quietest day during April 1945 was the 27th and the day of the largest disturbance the 11th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
3, 9, 10, 16–18, 21–23, 25–29	2, 4–8, 12–15, 19, 20, 24, 30	1, 11

No magnetic storms were recorded during April 1945 while one disturbance of moderate intensity was recorded during the month last year.

Mean character figure for April 1945 was 0·60 as against 0·63 for April 1944.

M. R. RANGASWAMI.

Magnetic conditions during May 1945 were far less disturbed than in the previous month. There were 20 *quiet* days and 11 days of *slight* disturbance as against identical numbers of quiet days and slightly disturbed days in May 1944.

The quietest day during the month was the 22nd and the day of the largest disturbance the 11th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days
	Slight
1–8, 13, 15, 19–24, 26, 28, 29, 31.	9–12, 14, 16–18, 25, 27, 30.

No magnetic storm occurred during May 1944 or 1945.

The mean character figure for May 1945 was 0·35 as against 0·26 for May 1944.

M. R. RANGASWAMI.

773-45 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Rau, M.A., Ph.D., for The Current Science Association Bangalore